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Gayl

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(54) **HIGH INTENSITY DIRECTED LIGHT AND SOUND CROWD DISPERSION DEVICE**

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(51) **Int. Cl.**[7] **H04B 1/034**
(52) **U.S. Cl.** **367/139**; 367/137; 181/142
(58) **Field of Search** ..... 367/139, 138, 367/137; 181/142; 116/22 A; 381/75

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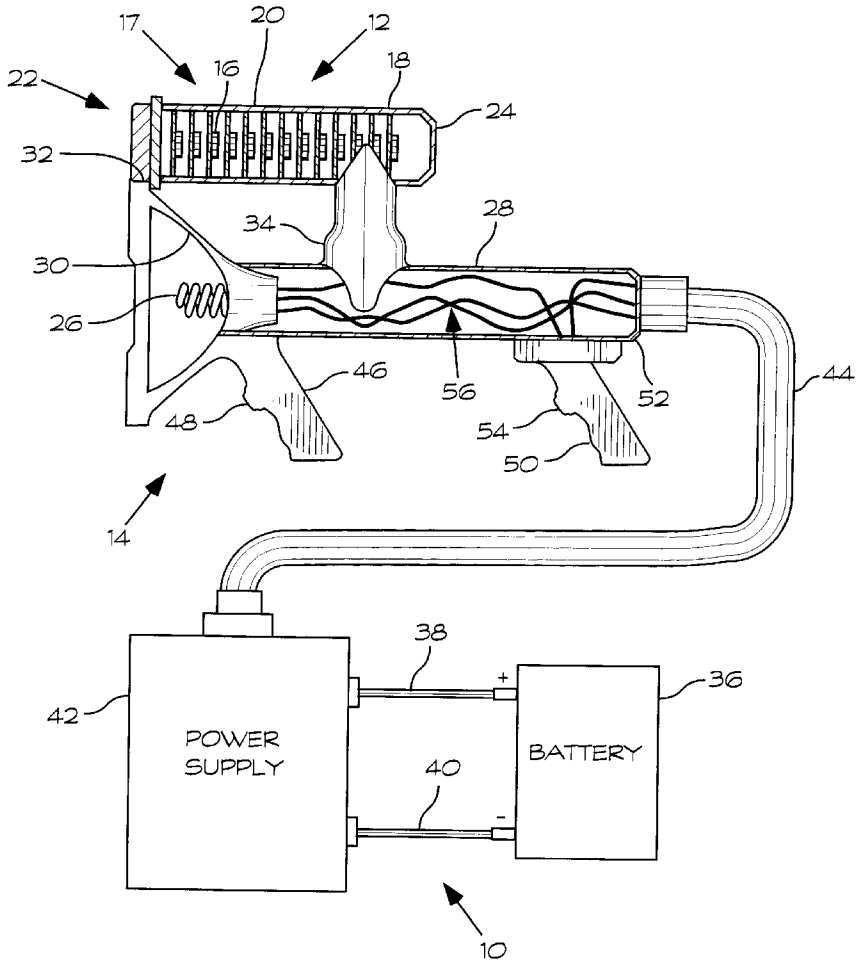
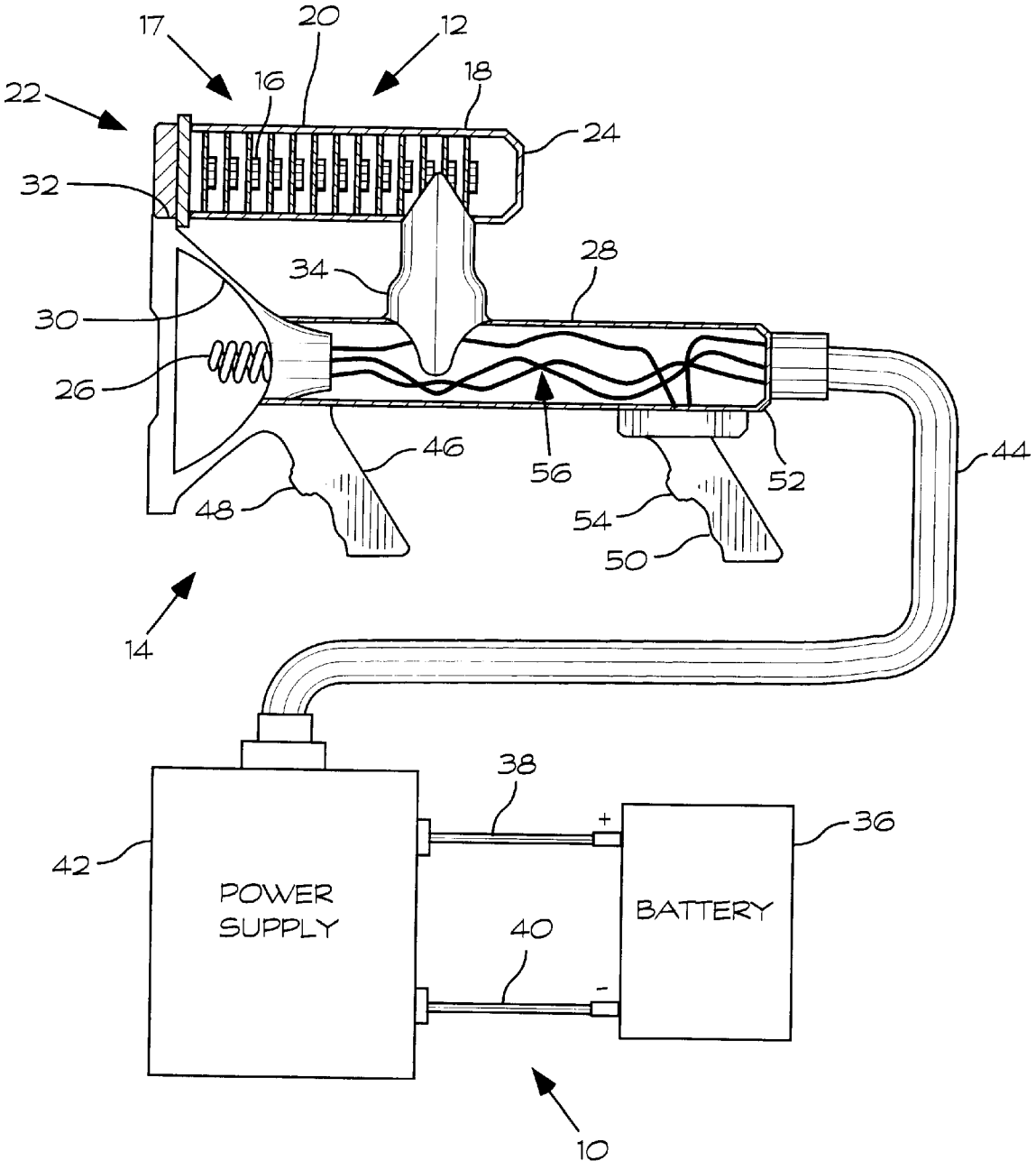
(57) **ABSTRACT**

A device for influencing human behavior comprises an audio system arranged to produce a sound wave that may be directed to a selected location and a video system arranged to produce a light beam that may be directed to the selected location. The audio system preferably comprises a frame and an array of sound generators mounted in the frame; The frame preferably is formed generally as a tube having a longitudinal axis, an open end and a closed end with the sound wave being emitted generally parallel to the longitudinal axis of the tube. The video system preferably comprises either a flash tube or a laser.

3 Claims, 4 Drawing Sheets

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14
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POWER SUPPLY
40
BATTERY
10

FIG. 1

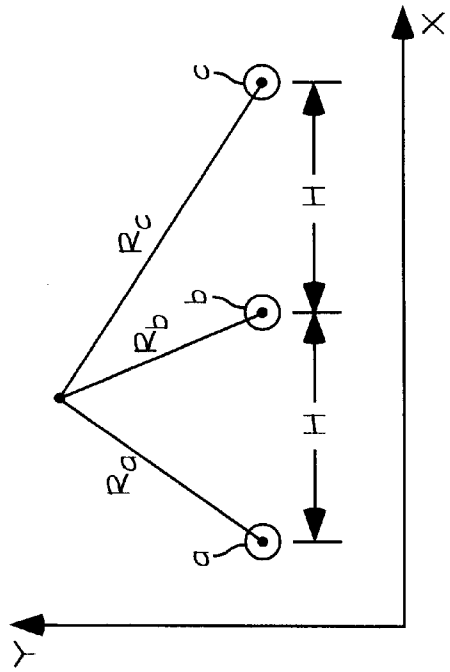


FIG. 2

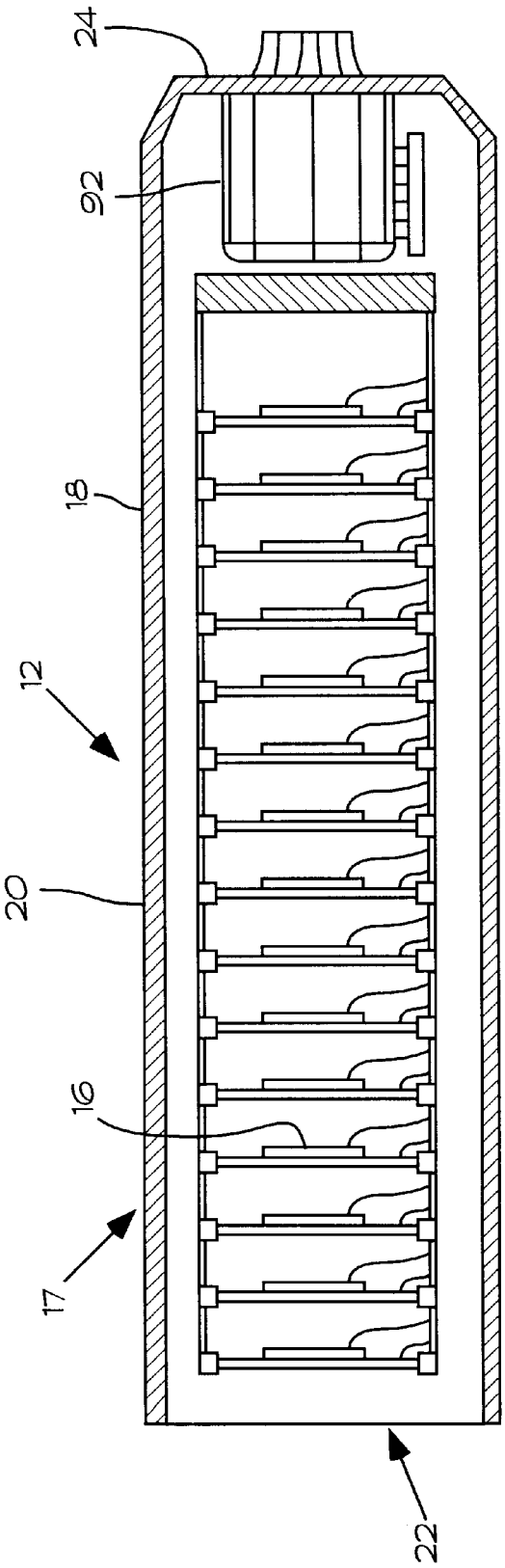
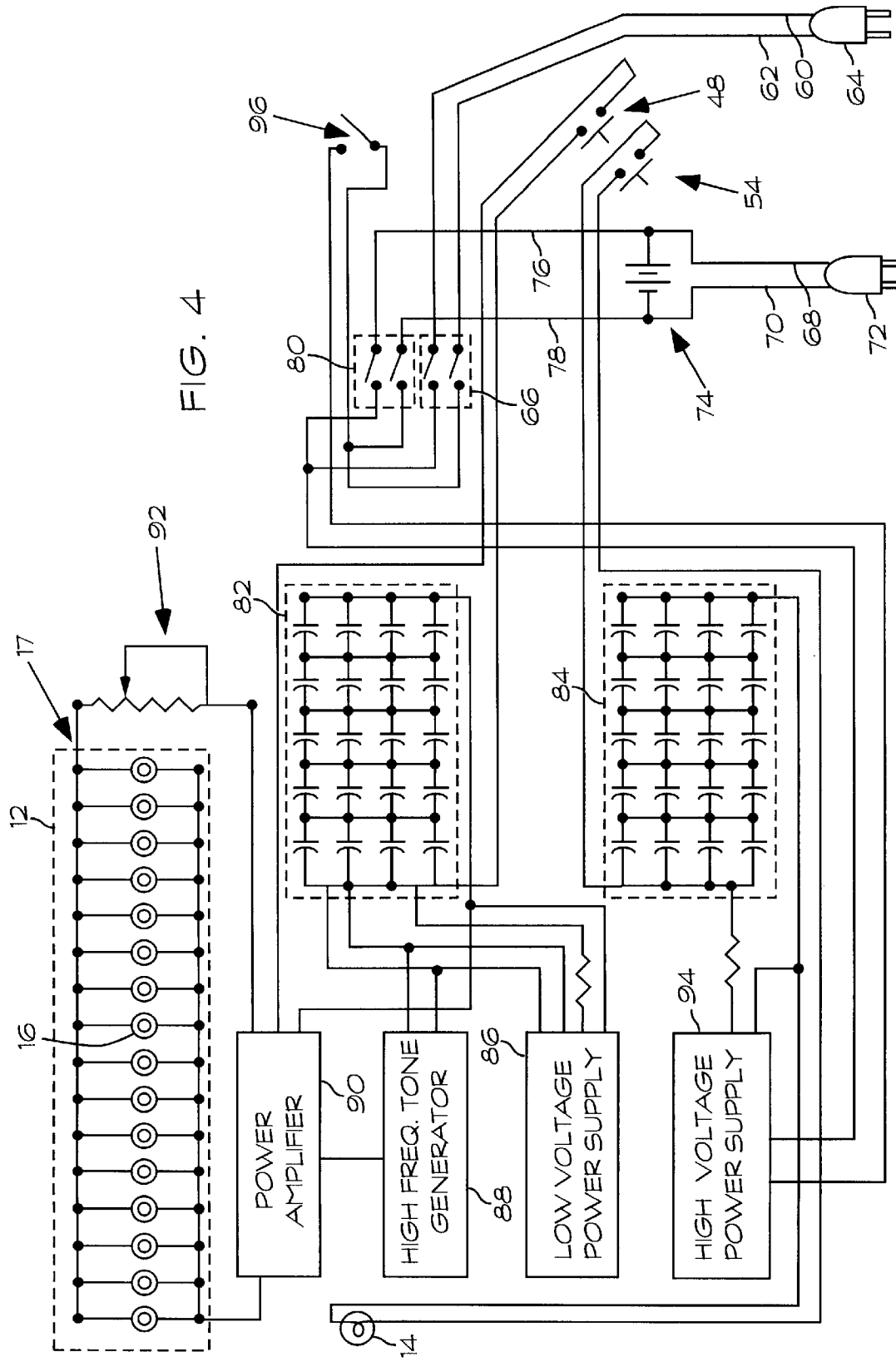


FIG. 3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48
62
60
64
54
76
70
68
72
78
74
80
66
92
82
84
17
12
16
94
POWER AMPLIFIER
90
HIGH FREQ. TONE GENERATOR
88
86
LOW VOLTAGE POWER SUPPLY
HIGH VOLTAGE POWER SUPPLY
14

FIG. 4

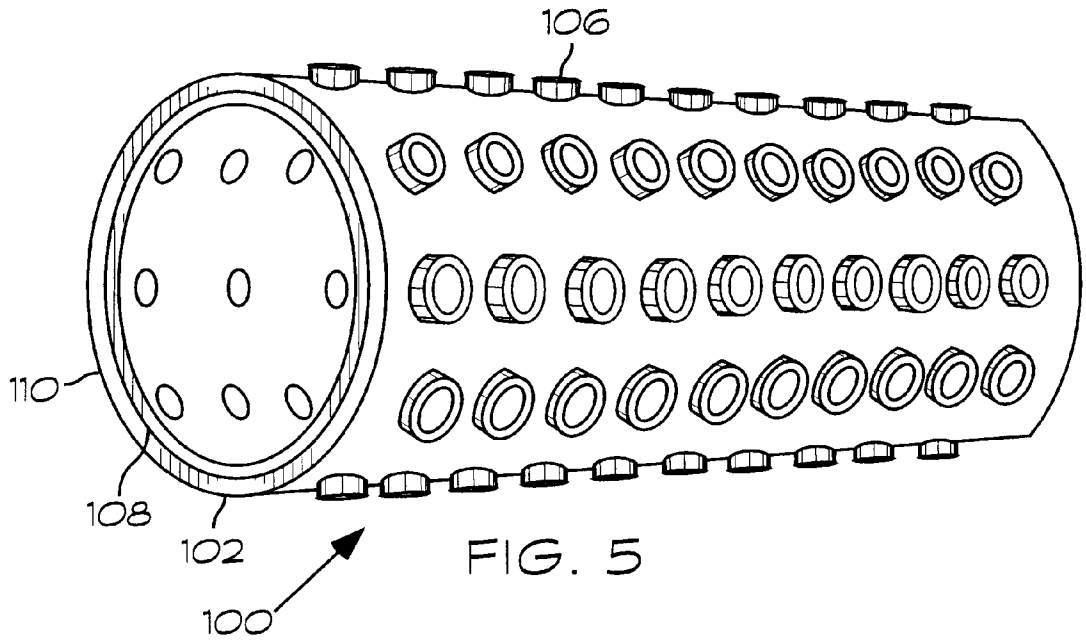

FIG. 5

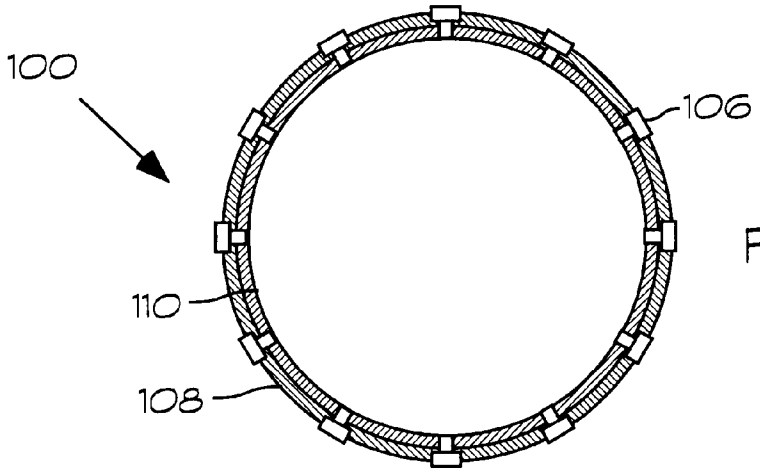

FIG. 6

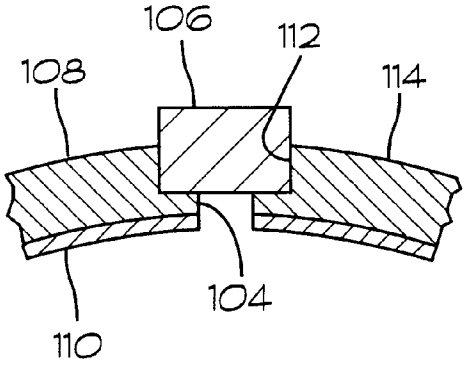

FIG. 7

HIGH INTENSITY DIRECTED LIGHT AND SOUND CROWD DISPERSION DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to crowd control devices and particularly to devices for use by law enforcement and military forces during civil disturbances to control unruly crowds of people without causing serious injury. Still more particularly, this invention relates to a device that uses sonic and light beams to control human behavior.

2. Description of the Prior Art

A large variety of less-than-lethal systems and devices are currently available for employment by law enforcement and military forces in civil disturbances. Riot batons, rubberized metal pellets, chemical agents, water, foam and firearms represent crude and visually offensive technologies intended to minimize serious injury and death during civil unrest. Unfortunately, technologies and their employment suffer weaknesses that often defeat the purpose of avoiding violent escalation. Many are unable to selectively hold a mob at bay, in essence, outside of rock and Molotov cocktail throwing range. Once a mob is able to assault forces with hand thrown projectiles, the employment of deadly force becomes more probable because forces are directly threatened. Many methods are logistically impractical (high pressure water, foam, etc.), which limits their application. Other methods, such as gas, are indiscriminate in their effects, endangering both non-combatants and friendly forces during engagements. Kinetic projectile firing devices (bean bag rounds, rubber bullets, etc.) can, in many instances, maim or kill their targets in contradiction to their purpose. Finally, the employment of such systems is visually offensive from a media or neutral observer standpoint, often resulting in severe harm to law enforcement and military missions due to political disenchantment.

SUMMARY OF THE INVENTION

This invention is a portable, combined arms, audio-visual system intended for humane deterrence, riot control and the defusing of possible escalation of civil violence. The audio sub-system generates a directional acoustic beam by means of a linear arrangement of piezoelectric transducers, which are phased to produce directionality and power in the forward direction. The longitudinal end-fired-array is contained within an insulated and internally reflective tube to employ resonance to increase sound pressure levels, while protecting the operator and his team-mates from effects. The intended effect of the acoustic energy is to produce aural pain in an adversary sufficient to deter or prevent a continuation of threatening behavior. The audio sub-system can be operated in a large variety of modes, including the enhancement of a single frequency by phasing, a combination of beat frequencies by separate control of two oscillators, a shift in frequency operation, or a randomized, intermittent operation.

The audio sub-system operates in combination with a pulsed, diffusive laser or flash device. The integration of any one of many off-the shelf, eye-safe, pulsed dazzle-producing light systems accomplishes the unique combined arms concept. While such lasers have been separately developed and patented, this invention uniquely integrates them with acoustic effects, with the intent of causing an adversary synergistic sensory overload, thereby increasing the deterrent and preventative effects of the combined device. In summary, this system provides synergistic and temporary discomfiture to two senses, discouraging further civil aggression at safe stand-off range. It also possesses rheostatic tunability to vary the severity and range of effects.

The system is light-weight, man-portable and self contained. It can be scaled to various, frequencies, amplitudes and applications. All electronics for audio and laser/flash device operation may be carried in a backpack. Both systems are powered by batteries and low and/or high voltage capacitors for extended independent operations. The system can alternatively be plugged into vehicle or building power sources for uninterrupted operations. The system can also be scaled up in capability and flexibility for employment as a vehicle mounted crew served device of greater effective range.

A crowd dispersion device according to the present invention for influencing human behavior comprises an audio system arranged to produce a sound wave that may be directed to a selected location and a video system arranged to produce a light beam that may be directed to the selected location.

The audio system included in the present invention preferably comprises a frame and an array of sound generators mounted in the frame. The frame preferably is formed generally as a tube having a longitudinal axis, an open end and a closed end with the sound wave being emitted generally parallel to the longitudinal axis of the tube.

The array of sound generators is arranged to produce a plurality of sound waves having amplitudes that positively combine along the axis of the tube. The audio system may comprise a linear array of piezoelectric transducers mounted inside the frame. The audio system may alternatively comprise an array of piezoelectric transducers mounted on the tube and arranged to produce sound waves directed radially inward in the tube.

The audio system may alternatively comprise an array of sirens mounted on the tube and arranged to produce sound waves directed radially inward in the tube.

The video system preferably comprises either a flash tube or a laser.

The crowd dispersion device according to the present invention may further comprise an electrical system that may be controlled by a human operator to cause the light source and the sound cannon to produce a light beam and a sound wave, respectively, that may be directed to the selected location to encourage a person to move away from the selected location.

The crowd dispersion device according to the present invention may further comprise a power source selection switch connected to the electrical system, a first electrical connector arranged for connection between the electrical system and an external electrical power source. A battery may be connected to the power source selection switch such that a human operator may actuate the power source selection switch to control whether the electrical system receives electrical power from the battery or from the external electrical power source.

The device according to the present invention may further comprise a pair of pistol grips mounted to the frame and spaced apart a distance convenient for being grasped by a human operator, a sound cannon trigger mounted to a first one of the pistol grips and a light source trigger mounted to the other of the pistol grips.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 schematically illustrates a crowd control device according to the present invention;

FIG. **2** illustrates relationships between sound sources and a location where the sounds are received

FIG. **3** illustrates a sound generator that may be included in the crowd control device of FIG. **1**;

FIG. **4** illustrates electrical circuitry that may be included in the crowd control device of FIG. **1**;

FIG. **5** is a perspective view of an alternate embodiment of an acoustic cannon that may be included in the present invention;

FIG. **6** is an end elevation view of the acoustic cannon of FIG. **5**; and

FIG. **7** is a cross sectional view of a portion of the acoustic cannon of FIG. **5**.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIG. **1**, a crowd control device **10** according to the present invention includes an acoustic cannon **12** and a light source **14**. The acoustic cannon **12** of FIG. **1** may include a plurality of sound sources **16** arranged in a linear array **17**. The sound sources **16** may be mounted inside a housing **18** that preferably is formed as a tube **20** having an open end **22** and a closed end **24**. The sound sources **16** are preferably commercially available piezoelectric transducers.

The operation of the linear array **17** of sound sources **16** is based on the phasing, spacing, and/or frequency mixing of this array. This is to produce acoustic reinforcement forward, and partial cancellation sideways. This is illustrated mathematically by three simple point source piezoelectric transducers, a, b, c, operating in open space, and operating at frequencies f_a, f_b and f_c, which can be identical or different, with phases ϕ_a, ϕ_b and ϕ_c, respectively.

As shown in FIG. **2**, the sound sources **16** are uniformly spaced a distance H apart at one-third wavelength apart, may be written as $H=\lambda/3$ where λ is the wavelength.

The expression for pressure propagation from such a source is:

$$P_a(R_a, t) = A\exp\left(\frac{i(\omega_a t - kR_a - \phi_a)}{R_a}\right). \quad (1)$$

If all frequencies are the same, f_a, the sources uniformly phased (0, 120, 240 degrees), and the spherical distance from each source is R_a, R_b and R_c, and the amplitude summation in taken in the x-y plane only (x along the planar array, and y perpendicular), the summation of the pressure amplitudes is

$$\sum P = A\sin\left(\frac{\omega_a t - k\sqrt{x_a^2 + y_a^2}}{\sqrt{x_a^2 + y_a^2}}\right) + B\sin\left(\frac{\omega_b t - k\sqrt{x_b^2 + y_b^2} - \frac{2\pi}{3}}{\sqrt{x_b^2 + y_b^2}}\right) + C\sin\left(\frac{\omega_c t - k\sqrt{x_c^2 + y_c^2} - \frac{2\pi}{4}}{\sqrt{x_c^2 + y_c^2}}\right), \quad (2)$$

where R_a is the radial distance in terms of its x and y components. The spacing of sources=$H=f/k=\lambda/3$ where k is the wavelength number=$2\pi/\lambda$. If ϕ_a is set=0, then $\phi_b=\lambda k/3=2\pi/3$, and $\phi_c=2Hk=4\pi/3$. The sound sources typically operate at about 3400 Hz.

As shown in FIG. **1**, the light source **14** may include a flash tube **26** mounted at an end of a tubular frame **28**. The light source may alternatively comprise a suitable laser (not shown). A reflector **30** preferably is arranged to reflect light emitted from the flash tube **26** so that an intense light beam is directed parallel to the sound waves emitted from the acoustic cannon **12**. The acoustic cannon **12** may be mounted to an edge **32** of the reflector **30** and to a mounting post **34** that extends between the tube **20** and the frame **28**.

Electrical power may be provided by a battery **36** or by an external source (not shown). Suitable leads **38** and **40** connect the battery **36** to a power supply **42** that provides suitable electrical power to the acoustic cannon **12** and the light source **14**. The battery **36** and power supply **42** may be arranged to be carried in a backpack (not shown) so that the crowd control device is man-portable.

A flexible conduit **44** carries electrical leads for providing electrical power to the acoustic cannon **12** and the light source **14**. A first pistol grip **46** extends from the housing **28** near the light source **14**. A sound cannon trigger **48** is mounted in the pistol grip **46**. A second pistol grip **50** is extends from the housing **28** near its rear end **52**. An light source trigger **54** is mounted in the pistol grip **50**. Electrical leads **56** are connected to the acoustic cannon **12**, the light source **14**, the sound cannon trigger **48** and the light source trigger **54** so that a person operating the crowd control device **10** may conveniently actuate the acoustic cannon **12** and/or the light source **14**.

FIG. **3** shows additional structural features of the acoustic cannon **12**. The piezoelectric acoustic transducers **16** are connected in series and linearly spaced apart in the housing **18** so that positive acoustic wave reinforcement occurs in the housing **18** as the piezoelectric acoustic transducers **16** are energized. The tube **20** is closed at the back end **24**, and phase reinforcement enhances forward propagation toward the open end **22**.

FIG. **4** shows circuitry of an embodiment of the crowd control device **10** that is designed for connection to an external power source (not shown). Electrical leads **60** and **62** from a connector **64** for an external power source (not shown) are connected to a first power source selection switch **66**. Electrical leads **68** and **70** extend from a connector **72** for an external power source (not shown) are connected to a rechargeable battery **74**. Electrical leads **76** and **78** extend between the battery **74** and a second power source selection switch **80**.

An operator uses the power source selection switches **66** and **80** to provide electrical power to the acoustic cannon **12** and to the light source **14**. Turning on the power source selection switches **66** and **80** charges corresponding capacitor banks **82** and **84**. When the crowd control device **10** is to be used, the operator actuates the sound and light triggers **48** and **54** as necessary.

Actuation of the sound control switch **48** causes the capacitor bank **82** to discharge into a power supply **86**, a tone generator **88** and a power amplifier **90**. The power amplifier **90** provides the amplified signal output from the tone generator **88** to the array **17** of sound generators **16**. A potentiometer **92** may be used to control the voltage applied to the sound generators **16**. Controlling the sound generator voltage allows the user to control the amplitude of the sound output from the acoustic cannon **12**.

Actuation of the light control switch **54** causes the capacitor bank **84** to discharge into a high voltage power supply **94** that provides electrical power to the light source **14**.

FIGS. **5–7** illustrate an acoustic cannon **100** that may be included in the crowd control device **10** according to the present invention. The acoustic cannon **100** comprises a tube assembly **102** having a plurality of radial passages **104**

therein. The tube **102** has an open end and a closed end as described above. In each of the passages **104** there is mounted a sound source **106**. The sound sources **106** are preferably either piezoelectric transducers as described above or sirens.

The tube assembly **102** preferably includes an inner tube **108** formed of a metal such as aluminum and an outer tube formed of a material such as PVC. Each sound source **106** preferably is formed to have a generally cylindrical outer configuration. Each sound source **106** is preferably mounted in a corresponding cylindrical recess **112** formed in the outer wall **114** of the PVC outer tube **110** as best shown in FIG. **7**. The passages **104** are formed in the bottom center portion of each recess **112** so that the sound sources **106** are mounted on circular ledges in the outer tube **110**.

The sound sources preferably are arranged in a plurality of angularly spaced linear arrays as shown in FIG. **5**. The sound waves emitted from the sound sources **106** enter the tube **102** via the passages **104** and combine to form a high amplitude wave that is emitted from the open end of the tube **102**.

The structures and methods disclosed herein illustrate the principles of the present invention. The invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects as exemplary and illustrative rather than restrictive. Therefore, the appended claims rather than the foregoing description define the scope of the invention. All modifications to the embodiments described herein that come within the meaning and range of equivalence of the claims are embraced within the scope of the invention.

What is claimed is:

1. An audio-visual device for deterring human behavior, comprising:

a frame formed generally as an elongate tube having a closed end and an open end;

a light source mounted to the open end of the frame and arranged to produce a light beam that may be directed to a selected location;

a sound cannon mounted to the frame arranged to produce a sound wave that may be directed out the open end of the frame to the selected location;

an electrical system that may be controlled by a human operator to cause the light source and the sound cannon to produce a light beam and a sound wave, respectively, that may be directed to the selected location to encourage a person to move away from the selected location;

a pair of pistol grips mounted to the frame and spaced apart a distance convenient for being grasped by a human operator;

a sound cannon trigger mounted to a first one of the pistol grips; and

a light source trigger mounted to the other of the pistol grips.

2. An audio-visual device for deterring human behavior, comprising:

a frame formed generally as an elongate tube having an open end and a closed end;

a light source mounted to the open end of the frame and arranged to produce a light beam that may be directed to a selected location;

a sound cannon mounted to the frame arranged to produce a sound wave that may be directed out the open end of the frame to the selected location;

an electrical system that may be controlled by a human operator to cause the light source and the sound cannon to produce a light beam and a sound wave, respectively, that may be directed to the selected location to encourage a person to move away from the selected location;

a power source selection switch connected to the electrical system;

a first electrical connector arranged for connection between the electrical system and an external electrical power source; and

a battery connected to the power source selection switch such that a human operator may actuate the power source selection switch to control whether the electrical system receives electrical power from the battery or from the external electrical power source.

3. A centralized end-fired array combination audio-visual device for influencing human behavior, comprising:

a longitudinal insulated and internally reflective tube having a closed end and an open end;

a sound cannon audio generating system having an array of piezoelectric transducers mounted on the tube and arranged to produce sound waves directed radially inward and out the open end towards a selected location;

a visual light system mounted in the open end of the tube to produce a light beam that may be used independently or in combination with the audio system and directed to a selected location;

a pair of pistol grips mounted to the tube and spaced apart a distance convenient for being grasped by a human operator;

a sound cannon audio trigger mounted to a first one of the pistol grips and a light source trigger mounted to the second of the pistol grips so that they may be engaged independently or in combination at any time;

an electrical system that may be controlled by an operator to cause the sound cannon audio source and the light source to produce a sound wave and a light source independently or in combination and directed towards a selected location to encourage a person to move away from the location;

a power source selection switch connected to the electrical system;

a first electrical connector arranged for connection between the electrical system and an external electrical power source;

a second electrical connector arranged for connection between the electrical system and a battery so that an operator may actuate the power source selection switch to control whether the electrical system receives power from the battery or from an external power source.

* * * * *